Claims

1. Method for producing a bristle from thermoplastic polymers through injection molding, wherein the molten polymer mass is injected under pressure into a bristle-molding channel of predetermined length having a predetermined cross-sectional shape along this length and the channel is vented during injection molding, characterized in that the magnitude of the injection pressure is adjusted in dependence on the cross-sectional size of the bristle-molding channel such that a shear flow is generated with high core speed in the center of the molten polymer mass flow and large shearing effect due to wall friction of the molten polymer mass under distinct longitudinal orientation of the polymer molecules at least in the region of the molten polymer mass close to the wall and maintained along the channel, wherein the channel is simultaneously vented along its length to support maintenance of the shear flow.

2. Method according to claim 1, characterized in that the injection pressure acting on the molten polymer mass is set, depending on the cross-sectional shape of the bristle-molding channel, to preferably at least 500 bar ($0.5 \cdot 10^5$kPa).

3. Method according to claim 1 or 2, characterized in that the injection pressure is set to 2000 to 5000 bar ($2 \cdot 10^5$ kPa to $5 \cdot 10^5$ kPa).

4. Method according to any one of the claims 1 through 3, characterized in that the injection pressure is set such that the molten polymer mass in the bristle-molding channel has a specific pressure of more than 300 bar ($0.3 \cdot 10^5$ kPa).

5. Method according to any one of the claims 1 through 4, characterized in that, with given cross-sectional shape and length of the bristle-molding channel, the injection pressure is set to support the crystal seed formation between neighboring longitudinally oriented molecular sections.

6. Method according to any one of the claims 1 through 5, characterized in that the bristle-molding channel is cooled.

7. Method according to any one of the claims 1 through 6, characterized in that the bristle-molding channel is vented transverse to the flow direction of the molten polymer mass.

8. Method according to claim 7, characterized in that the bristle-molding channel is vented in several planes disposed transverse to the flow direction of the molten polymer mass.

9. Method according to claim 8, characterized in that the bristle-molding channel is vented along its length via planes disposed at approximately equal distances.

10. Method according to any one of the claims 1 through 9, characterized in that the bristle-molding channel is vented of air displaced by flow pressure of the molten polymer mass.

11. Method according to any one of the claims 1 through 10, characterized in that the channel is vented with the support of an external underpressure.

12. Method according to any one of the claims 1 through 11, characterized in that the molten polymer mass is injected into a

bristle-molding channel with a cross-section which remains substantially the same, beginning at the injection side.

13. Method according to any one of the claims 1 through 12, characterized in that the molten polymer mass is injected into a bristle-molding channel having a cross-section which tapers substantially continuously from the injection side.

14. Method according to any one of the claims 1 through 13, characterized in that the molten polymer mass is injected into an inlet region which narrows like a nozzle towards the bristle-molding channel for producing an extension flow.

15. Method according to any one of the claims 1 through 14, characterized in that the molten polymer mass is injected into a bristle-molding channel whose cross-sectional shape has at least one discontinuity in the form of a tapering in the flow direction of the molten polymer mass.

16. Method according to any one of the claims 1 through 15, characterized in that the cross-section of the bristle-molding channel is selected to have a maximum width of ≤ 3mm.

17. Method according to claim 16, characterized in that the ratio of the largest width to the length of the channel is selected to be ≤ 1:5.

18. Method according to claim 17, characterized in that the ratio of the largest width to the length of the channel is selected to be ≤ 1:10.

19. Method according to claim 17, characterized in that the ratio of the largest width to the length of the channel is selected to be $\leq 1:250$.

20. Method according to any one of the claims 1 through 19, characterized in that the molten polymer mass is simultaneously injected into several neighboring bristle-molding channels thereby forming a corresponding number of bristles.

21. Method according to claim 20, characterized in that the molten polymer mass is injected into the neighboring bristle-molding channels thereby simultaneously forming a connection between at least two bristles.

22. Method according to claim 20, characterized in that after injection of the bristles, a molten polymer mass of another polymer is subsequently injected, thereby forming a connection between at least two bristles.

23. Method according to any one of the claims 20 through 22, characterized in that the molten polymer mass is injected to form a bristle support which connects at least two or more bristles.

24. Method according to claims 21 to 23, characterized in that the molten polymer mass is injected to form a bristle support which connects the bristles and forms the brush body.

25. Method according to claim 23, characterized in that at least one further molten polymer mass from another polymer is injected onto the bristle support.

26. Method according to any one of the claims 20 through 25, characterized in that a number of bristles are injected with different lengths.

27. Method according to any one of the claims 20 through 26, characterized in that a number of bristles are injected with different cross-sections.

28. Method according to any one of the claims 20 through 27, characterized in that a number of bristles are injected with a cross-sectional shape, which changes along their lengths.

29. Method according to any one of the claims 20 through 28, characterized in that a plurality of bristles are injected with parallel mutual orientation.

30. Method according to any one of the claims 20 through 28, characterized in that at least one part of the bristles is injected in a non-parallel fashion.

31. Method according to any one of the claims 20 through 30, characterized in that bristles of a same geometry but different bending elasticity (hardness) are produced through injection-molding of different molten polymer masses in the same molding channels.

32. Method according to any one of the claims 1 through 31, characterized in that the bristles are injected from a polymer or a polymer mixture, which has reduced secondary binding forces in the solidified state.

33. Method according to any one of the claims 1 through 32, characterized in that the bristles are injected from a polymer including additives, which become active during use.

34. Device for injection molding of bristles from thermoplastic polymers, comprising a means for producing an injection pressure and an injection mold which has at least one supply channel for the molten polymer mass and at least one cavity in the form of a molding channel having a mold contour corresponding to the length and the cross-sectional shape of the bristle to be produced, wherein the molding channel has an associated venting means for release of the air displaced during injection molding, characterized in that the injection pressure means is designed for generating an injection pressure of at least 500 bar ($0.5 \cdot 10^5$ kPa) and the venting means have venting cross-sections distributed along the length of the molding channel which are designed, in cooperation with the injection pressure, for forming a shear flow with high core speed in the center of the molten polymer mass and large shearing effect on the wall of the molding channel.

35. Device according to claim 34, characterized in that the means for generating the injection pressure is designed such that injection pressures of between 2000 and 5000 bar ($2 \cdot 10^5$ kPa to $5 \cdot 10^5$ kPa) can be set depending on the length and cross-sectional shape of the molding channel.

36. Device according to claim 34 or 35, characterized in that the means for generating an injection pressure and the venting cross-sections on the molding channel are designed such that the molten polymer mass in the molding channel has a specific pressure of at least 300 bar ($0.3 \cdot 10^5$ kPa).

37. Device according to any one of the claims 34 through 36, characterized in that the injection pressure can be controlled depending on the length and the cross-sectional shape of the molding channel.

38. Device according to any one of the claims 34 through 37, characterized in that the venting means have venting cross-sections, which can be controlled depending on the specific pressure.

39. Device according to any one of the claims 34 through 38, characterized in that the injection mold with molding channel has an associated coolant.

40. Device according to claim 39, characterized in that the molding channel in the injection mold has an associated coolant.

41. Device according to any one of the claims 34 through 40, characterized in that the injection mold consists of several molding plates which are layered transverse to the longitudinal extension of the molding channel, each defining a longitudinal section of the molding channel.

42. Device according to claim 41, characterized in that the venting means are formed on the molding plates.

43. Device according to claim 42, characterized in that the venting means are formed between the mutually facing support surfaces of the molding plates.

44. Device according to claim 43, characterized in that the venting means are formed through gaps between the mutually facing surfaces of the molding plates.

45. Device according to claim 43, characterized in that the venting means are formed by surface roughnesses on the surfaces of the molding plates.

46. Device according to any one of the claims 34 through 45, characterized in that the venting means have venting cross-sections with a width of between 5μm and 300μm at the mold surface of the molding channel.

47. Device according to any one of the claims 34 through 46, characterized in that the venting means have venting cross-sections, which widen outwardly, starting from the mold surface of the molding channel.

48. Device according to any one of the claims 34 through 47, characterized in that the venting means are connected to an external underpressure source.

49. Device according to any one of the claims 34 through 48, characterized in that the molding channel has a cross-section, which remains substantially constant along its length.

50. Device according to any one of the claims 34 through 48, characterized in that the molding channel has a cross-section, which tapers substantially uniformly towards its end.

51. Device according to claim 50, characterized in that the molding channel has a linear axis and tapers with an angle of less than 1.0 degrees (mold slope).

52. Device according to any one of the claims 34 through 51, characterized in that the molding channel has a cross-section, which tapers discontinuously towards the end.

53. Device according to any one of the claims 34 through 52, characterized in that the largest width of the cross-section of the molding channel is ≤ 3mm.

54. Device according to any one of the claims 34 through 53, characterized in that at least one injection-side molding plate, having a widening which narrows towards the molding channel, is connected to the molding channel upstream of the molding channel at a side facing the supply channel.

55. Device according to any one of the claims 34 through 54, characterized in that the ratio of the largest width of the cross-section of the molding channel to its length is between 1:5 and 1:1000.

56. Device according to any one of the claims 34 through 55, characterized in that the number and thickness of the molding plates is matched to the length of the molding channel.

57. Device according to any one of the claims 34 through 56, characterized in that the number of molding plates is inversely proportional to the ratio of the largest inside diameter of the cross-section to the length of the molding channel.

58. Device according to any one of the claims 34 through 58, characterized in that the molding plates have a thickness, which is approximately three to fifteen times the average diameter of the molding channel.

59. Device according to any one of the claims 34 through 58, characterized in that the molding plates can be moved perpendicular to the plane of the plate, either individually or in groups.

60. Device according to any one of the claims 34 through 59, characterized in that at least some molding plates can be displaced parallel to the neighboring molding plates.

61. Device according to claim 59 or 60, characterized in that the molding plates can be sequentially removed, individually or in groups.

62. Device according to any one of the claims 59 through 61, characterized in that during release from the mold, the molding plate facing the supply channel can be removed last.

63. Device according to any one of the claims 34 through 62, characterized in that the injection mold has molding channels of different lengths and/or different cross-sectional shapes.

64. Device according to any one of the claims 34 through 63, characterized in that a standard structure of the injection mold for producing bristles of a given length has a number of molding plates standardized thereto and a standardized number of molding plates can be removed or inserted to vary the bristle length.

65. Device according to any one of the claims 34 through 64, characterized in that the injection mold has molding channels with a central axis which extends at an angle which is inclined relative to the direction of motion of the molding plates and each molding plate has a longitudinal section of the molding channel which is dimensioned such that release from the mold is possible through successive removal of the individual molding plates, despite the angular deflection.

66. Device according to any one of the claims 34 through 65, characterized in that the injection mold comprises molding channels with a central axis which is curved relative to the direction of motion of the molding plates and each molding plate has a longitudinal section of the molding channel which is dimensioned such that release from the mold is possible through successive lifting of the individual molding plates, in dependence on the curvature.

67. Device according to any one of the claims 34 through 66, characterized in that the injection mold has at least one molding plate which can be displaced in its plane relative to the neighboring molding plates to form, after injection molding of the bristles, a clamping means for all bristles which acts on the corresponding part of the length of the molding channel.

68. Device according to claim 67, characterized in that the molding plates forming the clamping means can be moved in the removing direction and opposite thereto.

69. Device according to claim 67 or 68, characterized in that the molding plates forming the clamping means can be moved together with the

clamped bristles after removal from the injection mold for handling spatial displacement of the bristles.

70. Device according to any one of the claims 67 through 69, characterized in that the molding plates forming the clamping means can be removed and replaced by a set of identical molding plates for renewed completion of the injection mold in a further injection cycle.

71. Device according to any one of the claims 34 through 70, characterized in that the injection mold consists of at least two groups of molding plates each having one clamping means, of which the first group comprises a part of the molding channel including the end and the other groups form the remaining part of the molding channel, wherein the first group can be subsequently removed from the second group and the second group from the further groups, with the injection process being divided into a number of injection molding cycles corresponding to the number of groups such that, in the closed initial position of the injection mold, the molten polymer mass is injected in a first injection molding cycle into the complete molding channel, whereupon the first group can be removed from the others thereby carrying along the blank via the clamping means, with the withdrawal path being shorter than the length of the blank, and additional molten polymer mass is subsequently injected into the freed longitudinal section of the molding channel in the further groups during a second injection molding cycle, and the steps injection/removal are repeated until the penultimate group is removed from the last group, to produce bristles of a greater length than the length of the molding channel, optionally from different polymers.

72. Device according to any one of the claims 34 through 71, characterized in that at least the molding plate defining the mold contour at the end of the molding channel can be replaced by a molding plate having another mold contour for generating bristles with ends having different shapes.

73. Device according to any one of the claims 34 through 72, characterized in that at least the molding plate having the mold contour at the end of the molding channel can be replaced by a molding plate with different longitudinal sections of the molding channels.

74. Device according to any one of the claims 34 through 73, characterized in that a mold cavity connecting two or more molding channels is disposed between the supply channel and the molding channels of the injection mold for forming a connection among the bristles.

75. Device according to claim 74, characterized in that the mold cavity is structured to produce a bristle support connecting all bristles.

76. Device according to claim 74 or 75, characterized in that the mold cavity is designed to produce a brush or paint brush body or part thereof.

77. Device according to any one of the claims 74 through 76, characterized in that the mold cavity is designed for generating a brush or paintbrush body or part thereof in a multiple component structure of different polymers.